MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

TIT3131 – INFORMATION THEORY

(All sections / Groups)

Question	Marks
TOTAL	

15 OCTOBER 2016
2.30 pm – 4.30 pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 12 pages with **Five** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the **blank spaces** provided.

QUESTION 1

(a) Describe **TWO** fundamental questions and answers of information theory.

[3 marks]

(b) Given a DMS, S = $\{S_0, S_1, S_2, S_3, S_4\}$ and the probability of occurrence for these symbols are showed in the following table.

k	0	1	2	3
S_k	S_0	S_1	S_2	S_3
p_k	*0.1*	*0.2*	*0.3*	***2x***
$I(s_k)$				

(i) Describe how to obtain the value of x and the amount of information gained on table above.

[3 marks]

k	0	1	2	3
S_k	S_0	S_1	S_2	S_3
p_k	*0.1*	*0.2*	*0.3*	*2x*
$I(s_k)$				

(ii) From your answer in part (i), describe the relationship between probability (p_k) and information gained $I(s_k)$.

[1 mark]

Continued...

(d) Define "**prefix code**" in information theory.

[1 mark]

(e) Consider the three source codes described in the Table below, identify which source code is a **not** a prefix code with your reason.

[2 marks]

Source symbol	Probability of occurrence	Code I	Code II	Code III
A	0.3	0	1	0
B	0.3	10	01	10
C	0.2	110	10	101
D	0.2	1110	110	111

QUESTION 2

(a) Explain the following codes I, II and III whether they are uniquely decodable using Kraft-McMillan inequality .

Symbol	*Code I*	*Code II*	*Code III*
A	0	0	0
B	10	10	100
C	01	11	110
D	100	111	111

[3 marks]

(b) From Q2(a), create a decision tree for code III and decode the sequence "1000111".

[2 marks]

(c) Create the Huffman code for the following DMS.

$$P(A) = 0.22,$$
$$P(B) = 0.15,$$
$$P(C) = 0.25,$$
$$P(D) = 0.05,$$
$$P(E) = 0.31,$$
$$P(F) = 0.02$$

[5 marks]

Continued...

QUESTION 3

(a) Briefly describe the relationship between entropy, conditional entropy, mutual information of communication channel.

[5 marks]

(b) State **THREE** parameters of Shannon's third theorem, the Channel Capacity Theorem (Information Capacity Theorem).

[3 marks]

(c) A channel has a bandwidth of 3 kHz and a S/N = 1500 at the channel output. Identify the reasons on why the system is condemned to a high probability of error when it operates at a rate greater 35k bits/sec.

[2 marks]

Continued...

QUESTION 4

Given that $P(Y|X) = \begin{bmatrix} 2/6 & 1/6 & 3/6 \\ 1/8 & 4/8 & 3/8 \end{bmatrix}$ and $p(x_j) = [5/8 \quad 3/8]$.

(a) Compute $p(y, x)$ and complete the following table.

$p(y_k, x_j)$	y_1	y_2	y_3	$p(x_k)$
x_1				5/8
x_2				3/8
$p(y_k)$				

[3 marks]

$p(y_k, x_j)$	y_1	y_2	y_3	$p(x_k)$
x_1				5/8
x_2				3/8
$p(y_k)$				

(b) Compute $H(Y)$ and $H(X)$.

[2 marks]

Continued...

(c) Compute P$(X|Y)$.

[1 mark]

(d) Calculate H(Y|X), H(X|Y) and $I(Y, X)$.

[4 marks]

QUESTION 5

(a) The following encoder describes a generator polynomial of a (15, 11) systematic cyclic code. Construct the syndrome calculator block diagram.

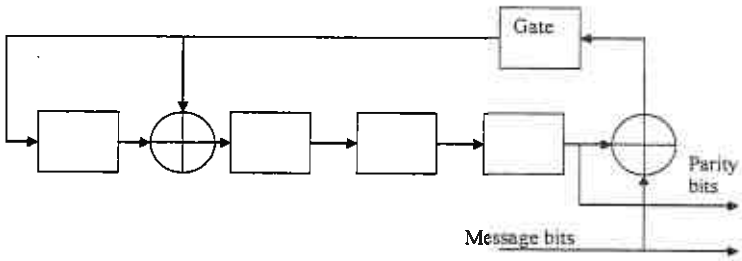

Figure 1: Encoder block diagram

[2 Marks]

(b) The generator polynomial g(D) a (7, 4) cyclic code is given by $g(D) = 1 + D + D^3$. Construct the generator matrix **G.**

[3 Marks]

(c) The generator polynomial of a (7, 4) cyclic code is $g(D) = 1 + D^2 + D^3$. Construct the valid code words for the following messages in **systematic** form.

Message	m(D)	c(D)	Codeword
0010			
0111			
1000			
1100			
1111			

[5 Marks]

Message	m(D)	c(D)	Codeword
0010			
0111			
1000			
1100			
1111			

End of Page